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RECORD OF REVISIONS

Rev	Date	Description	POC	OIC
0	06/28/99	Document rewritten to support LIR 220-03-01. Superceded Architectural Facilities Engineering Standards, Vol. 4, Manual Rev. 6, 2/17/98.	Miles Brittelle, <i>PM-DS</i>	Dennis McLain, <i>FWO-FE</i>
1	11/18/02	General revision and addition of endnotes. Replaces subsections 204, 205, 206, and 207.	Scott Richardson, <i>PM-1</i>	Kurt Beckman, <i>FWO-SEM</i>
2	8/16/04	Revised stair, guardrail, EIFS, window, landing, hardware, roofing, fall protection requirements.	Scott Richardson, <i>PM-DS</i>	Gurinder Grewal, <i>FWO-DO</i>
3	10/27/06	Administrative changes only. Organization and contract reference updates from LANS transition. IMP and ISD number changes based on new Conduct of Engineering IMP 341. Master Spec number/title updates. Other administrative changes.	Scott Richardson, <i>FM&E-DES</i>	Kirk Christensen, <i>CENG</i>

CONTACT THE ARCHITECTURAL STANDARDS POC
 for upkeep, interpretation, and variance issues

Ch. 4, B-Shell	<u>Architectural POC/Committee</u>
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B1010 EXTERIOR STAIRS

1.0 EXTERIOR CONCRETE STAIRS

- A. Exterior stairs shall be a minimum width of 4 feet clear from handrail to handrail.
- B. Provide slip-resistant stair treads with a tread slope of 1/8 inch per foot from back to front of tread.
- C. Provide risers with a minimum of 5 inches to a maximum of 7 inches in height.
- D. Avoid steps with less than 3 risers, as their lack of visual prominence creates a safety hazard.

2.0 HANDRAILS FOR EXTERIOR STAIRS

- A. Provide handrails for exterior steps on both sides of stairs.¹ Conform to LANL Building Code requirements for handrails (see ESM Chapter 16).
- B. Refer to LANL Master Specification 05 5200, Metal Railings.
- C. Mesh-type paneling (expanded metal or diamond mesh) for infill of rails and balusters is prohibited in office or business type occupancies [too unprofessional/industrial].

3.0 EXTERIOR PEDESTRIAN GUARDRAILS

- A. Install exterior guardrails when the top of the sidewalk, ramp or pedestrian area is 30 in. or greater above adjacent grade² (*or the adjacent downhill slope is 2:1 or greater*). Comply with LANL Building Code requirements for guardrails.
- B. Mesh-type paneling (expanded metal or diamond mesh) for infill of rails and balusters is prohibited in office or business type occupancies [too unprofessional/industrial].

B2010 EXTERIOR WALLS

1.0 GENERAL

- A. Any “system” of components shall be designed and specified as a system, approved and intended by the manufacturer. *Guidance: The preferred exterior facing products for offices and labs are brick and other masonry products. Portland cement-based stucco is preferred over EIFS.*
- B. Refer to the following LANL Master Specifications:
 - 1. Section 07 1113, Bituminous Dampproofing
 - 2. Section 07 2400, Exterior Insulation and Finish Systems

¹ 2003 ICC IBC, Section 1009.11.

² 2003 ICC IBC, Section 1012.

3. Section 09 9100, Painting
4. Section 08 9100, Louvers

2.0 THERMAL AND MOISTURE PROTECTION

- A. Limit interior building insulation combustibility to flame spread rating less than 25 and smoke developed less than 50.
- B. Exterior Insulation and Finish Systems (EIFS)
 1. EIFS shall be listed as an assembly in the Factory Mutual (FM) Approval Guide. Exception: EIFS color coat applied over Portland-cement-based 2-coat stucco.
 2. Care shall be exercised as to placement of EIFS such that application to locations subject to physical damage from impact, scuffing, puncture, penetration, etc are avoided or offered protection.
 3. *Guidance: Utilize manufacturer's methods of increasing impact resistance with use of heavy duty mesh inlays, or use of another material all together may be warranted. Typical locations to consider include, but are not limited to, doorways/entries, building corners, points where grade meets foundation, and locations where exterior door locksets may contact exterior walls.*
 4. Positive means of relieving moisture from the system shall be provided in accordance with the Manufacturer's standard design details – use of sealants alone at door/window frames, etc is inadequate.
 5. EIFS shall not be used on horizontal surfaces exposed directly to weather (soffits are not considered to be directly exposed to weather but measures conforming to the Manufacturer's standard details shall be taken to prevent moisture migration to soffit surfaces). Tops of parapets where EIFS is employed as the wall finish shall have sheet metal copings provided.
 6. Consideration to potential for bird damage shall be given when using rigid board insulation with a thickness greater than 2 inches.

B2020 EXTERIOR WINDOWS

1.0 GENERAL

- A. Refer to the following LANL Master Specifications.
 1. Section 08 4113, Aluminum-Framed Entrances and Storefronts.
 2. Section 08 5113, Aluminum Windows
- B. Storefronts and other large glass installations shall have horizontal mullions at 36" +/- above the walking surface to increase the glass visibility and reduce pane replacement costs.

- C. Large windows shall be provided with a means to wash them.³

B2030 EXTERIOR DOORS

1.0 GENERAL

- A. Use Underwriter's Laboratory (UL) or Factory Mutual (FM) approved labels on all doors, frames, and hardware required to be fire rated.
- B. Provide insulated metal doorframes.
- C. Provide concrete landings that lead to safe pedestrian ways a distance from the building that offers refuge from emergencies⁴. Slope landings away from door. Doors shall be provided with weather protection including prevailing wind.
- D. Refer to the following LANL Master Specifications.
 - 1. Section 08 1213, Hollow Metal Frames
 - 2. Section 08 1100, Metal Doors and Frames
 - 3. Section 08 3323, Overhead Coiling Doors
 - 4. Section 08 8000, Glazing

2.0 ACCESS CONTROLLED DOORS

- A. Comply with NFPA 101, Life Safety Code, for installation of access/egress controlled doors.
- B. Reader systems (badges, etc.) installed on the egress side shall not require activation to exit through the door.⁵
- C. Consult with Group SAFE-S3 (secured areas), ESM Electrical and Security Chapters, and the Fire Protection Group for specific design criteria.

³ EMRef-29 E-mails on SCC and NISC Issues from Maez and Ojeda to Oruch June-July-04 (Note: EMref refers to a Standards Program internal filing system for hard-to-find references).

⁴ 2003 ICC IBC, Section 1008.1.4.

⁵ NFPA 101-2003, Section 7.2.1.5.

3.0 DOOR HARDWARE⁶

- A. For interior doors use Best Lock Corporation 9K Series cylindrical locksets with Style 14 levers. For exterior doors not equipped with exit devices use Best 35H Series mortise locksets with Style 3 levers. No substitutions are allowed but, where Best locksets cannot work in the application, locks shall accommodate the installation and removal of a 7-pin changeable core manufactured by Best. The cores will be supplied and installed by LANL.
1. Primarily-keyless locks (PKLs -- e.g., cipher, push-button, digital) are only allowed for interior doors not protecting classified matter or exterior doors within security perimeters (e.g., moderate property protection and certain server rooms). PKLs shall: (1) meet ANSI/BHMA A156.2, *American National Standards for Bored and Preassembled Locks and Latches*; (2) be either mechanical or stand-alone/self-powered (no batteries); and (3) be configured to accept Best 7-pin cores for emergency bypass. PKL use in other locations and other types of locks require the approval of both Security Division (SEC-PSS5) and LANL Locksmith. *Guidance: PKLs are normally not approved for classified matter protection or perimeter doors in open areas due to combination control difficulties.*⁷
- B. Refer to LANL Master Specification 08 7100, Door Hardware.

B30 ROOFING

1.0 GENERAL

- A. Refer to Fig. B30-1 below for recommended decision-making process for component choices when undertaking a roofing task.
- B. The following criteria should first be determined for selection of roofing materials:
1. Life Expectancy of a structure, regardless of age, based upon condition and design life.
 2. Roof Structure (composition).
 3. Roof Pitch (slope).
 4. Projected roof use/traffic, including maintenance activities and potential exposures to chemicals.
 5. Energy efficiency and heat island reduction goals (*light color, LEED credit*)

⁶ LANL Lock Shop Standard. Provides high quality/durability and key-management benefits.

⁷ Former LANL Security Manual (SM-9-10 page 4, Oct 92; EMref-14) stated that keyless locks are “not resistant to picking and jimmying,” and permitted them only in locations stated. Another LANL locksmith concern is sharing of combinations. Avoiding battery maintenance is desirable. Related requirements are in [DOE M 5632.1C-1, 7/94 \[pg VIII-5 \(and VIII-6\)\]](#); related guidance in DOE [Office of Safeguards and Security] Security Container and Locking Device Guide, 10/93, Ch 6 (EMref-15).

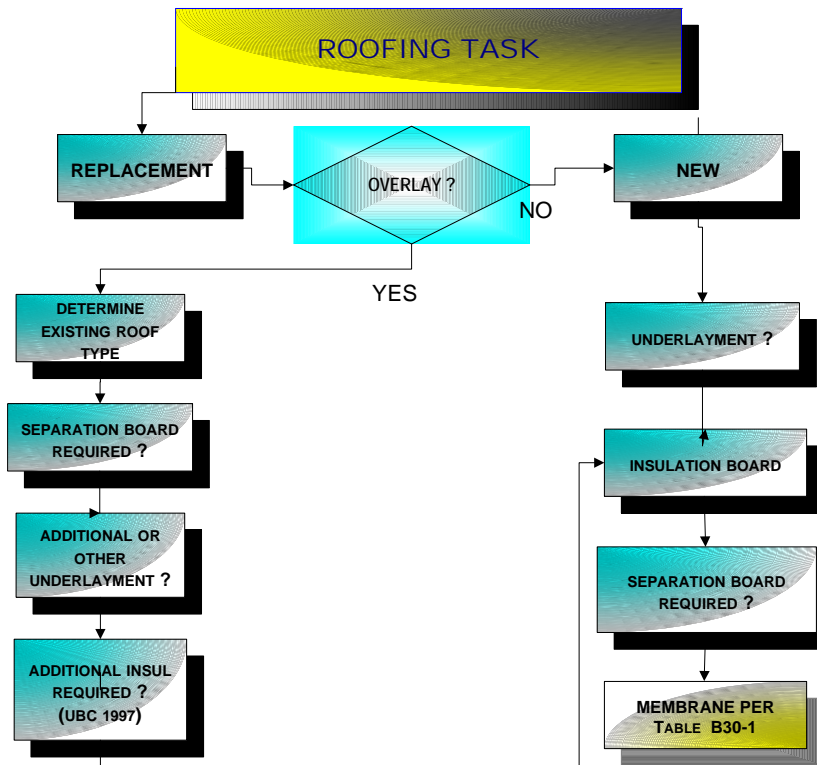


Figure B30-1- Roof Component Decision Flowchart

- C. Select new and reroofing systems from options listed in Table B30-1. Systems listed in Table B30-2 can only be used with written permission of the ESM Architectural POC. *Guidance: POC, Alternate, and FM&E Roofing SMEs can provide specification assistance.*

TABLE B30-1

Approved Roof Systems ⁸				
Roof Material	System Life Expectancy (years)	Pitch (Slope)	Traffic Tolerance (Light Duty)	Comments
CSPE (e.g., Hypalon®) fully adhered	30+	< 2 in 12	Quarterly Access	No grease or asphalt. Most are "Energy Star." Cannot be installed during winter due to adhesive viscosity.
SBS-Modified Bitumen Built-Up	30+	< 4 in 12	Weekly Access	No solvents
Metal	40+ (repair likely after 10+ if lapped seam)	>2 in 12	Semi-Annual	Easy traffic damage. Apply over wood deck or framework only.
Asphaltic Shingles	15+	> 3 in 12	Semi-Annual	Easy traffic damage. Existing wood deck only.

⁸ Life expectancies are as observed at LANL (high UV conditions). Other table data from LANL experience, industry standards, and manufacturer trade association documents listed below and in later endnotes. Also, SBS and Hypalon are capable of being recoated to extend their life. National Roofing Contractors Assoc. (<http://www.nrca.net>) Roofing and Waterproofing Manual and Handbook of Accepted Roofing Knowledge.

TABLE B30-2

Systems Requiring ESM Architectural Chapter POC's Written Approval for Use ⁹				
Roof Material	System Life Expectancy (years)	Pitch (Slope)	Membrane Traffic Tolerance (Light Duty)	Comments
CSPE Mechanically-fastened	20-30	< 2 in 12	Quarterly Access	Same as above, but screws allow leak migration, hinders leak location, has lower R-value, has fastener back-out and uplift issues,
EP	10+	<2 in 12	Semi-annual	Very limited experience
EPDM	10+	< 2 in 12	Semi-annual	Low UV resistance
PVC including DuroLast	10+	< 2 in 12	Semi-annual access	Low UV resist; low asphalt and petrochemicals resistance
Other elasto- and plasto-meric membranes including TPO	Variable	< 2 in 12	Variable	Limited or non-positive LANL experience
Sprayed-in-place foam	5+	<4 in 12	Quarterly access	Self-flashing; limited positive experience.
Unmodified Asphalt Built-up	15+	< 2 in 12	Quarterly access	Low UV resistance

- D. Vapor: Design roof systems to ensure that the dew point does not occur within the roof system (specify vapor barrier on substrate to prevent condensation formation).

⁹ Allowed roof types have the lowest life cycle costs for LANL. PVC, EPDM, and unmodified butumen rapidly embrittle at LANL's high UV levels, and there is little LANL experience with the other products in Table B30-2. The oldest PVC roofs in Los Alamos are SM-40 (circa 1998), the County pump station (circa 1/97, shrinkage found 2001), and TA-53-3, Sector G (circa 1997; after 5 years it had lost approx. 50% of original elasticity). PVC performance concerns are also discussed in (1) *Challenges of the 21st Century. Roofing Technology, Fourth (4th) International Symposium. Proceedings. First (1st) Edition. U.S. National Institute of Standards and Technology, U.S. National Roofing Contractors Association, Canadian Roofing Contractors Association, National Research Council of Canada, International Waterproofing Association, CIB, RILEM. September 17-19, 1997, Gaithersburg, MD, 253-264 pp, 1997* <http://www.fire.nist.gov/bfrlpubs/build97/art122.html> and (2) *Performance of Polyvinyl Chloride Roofing: An Overview* by Rossiter and Paroli published in *Proceedings of the Sustainable Low-Slope Roofing Workshop, ORNL, Oct 9-10, 1996, CONF-9610200, Desjarlais* <http://www.fire.nist.gov/bfrlpubs/build97/art047.html>. Stevens EP (TPO) was first used on the SCC in 2001 primarily due to the immediate availability of low noise specs on it. Variability in chemical formulations among TPO manufacturers and minimal high altitude durability data precludes further use at LANL until issues are resolved. Foam systems have shown poor historically poor performance for the Postal Service (1975-89), SRS (1982-1985), and many other locations; furthermore, there is a lack of local expertise to maintain or modify foam systems at LANL, and there are mechanical damage and UV degradation concerns. **Summary:** With high re-roofing costs and the tendency to occupy buildings beyond original intentions at LANL, the installation of short-life or unproven membranes is rarely justified.

- E. Wind Resistance: Design roof systems to comply with FM Class 1-90 Windstorm Resistance criteria or their equivalent. Calculate wind pressures on roofing based on the criteria in ASCE 7 or FM 1- 28. See ESM Structural Chapter for additional requirements.¹⁰
- F. Fire Resistance over Metal Decking: Specify FM Class 1 or UL Class A roofing assemblies. See Factory Mutual Data Sheet 1-28, the FM Approval Guide, or UL Fire Resistance Directories for acceptable materials and construction methods.¹¹ *Guidance: The two FM classes are:*
1. **Class 1 (acceptable)** - Includes construction with only minimal asphalt or other readily combustible material between the insulation and the metal deck. The vapor barrier is noncombustible.
 2. **Class 2 (unacceptable)** - Includes construction using larger quantities of asphalt for adhesion or wind resistance and/or asphalt-coated insulation between the insulation and the metal deck.
- G. Comply with LANL Master Specification 07 2113, Board Insulation or, for batt insulation, 07 2100, Insulation. *Guidance: Low-slope (e.g., “flat” roof systems typically involve a vapor barrier, board insulation, separation board (to protect insulation from compression), membrane, and traffic topping. Steep systems are typically metal or shingles (on transportables) with batt insulation (also protected by vapor barrier).*

2.0 ROOF SYSTEMS

2.1 Single-Ply CSPE (e.g., Hypalon®)¹²

- A. Follow guidelines set forth by the Single Ply Roofing Institute and National Roofing Contractors Association. Design with a minimum slope of 1/4 inch per foot. Membrane is to be fully adhered; mechanically-fastening is not to be used without ESM Architectural POC permission.
- B. Membrane shall be polyester reinforced, 45 mils minimum.
- C. Comply with LANL Master Specifications 07 5050, Membrane Roofing General Provisions; and 07 5316, Chlorosulfonate-Polyethylene Roofing (Hypalon).
- D. *Guidance: Hypalon® is a brand name of the Dupont Corporation.*

¹⁰ Wind loads per IBC-2003, Ch. 16 and, more applicably, FM Global Loss Prevention Data Sheets 1-28, *Wind Loads to Roof Systems and Roof Deck Securement*, Table 1, Ground Roughness Category B. Wind velocity zone 80 canyon average uplift plus 10 mph = 1-90 designation. Other relevant standards: FM 1-28S, *Wind Uplift Pressures on Roofs* and *FM Approval Guide*.

¹¹ ICC IBC-2003, Chapter 15.

¹² A mechanically fastened roofing system is not a preferred system because the screws back out (due to wind, e.g., HRL), there are wind uplift issues, and leaks are hard to locate/repair because the water migrates under the membrane. Information from SPRI -- Single Ply Roofing Institute (<http://www.spri.org>)

- A Professionals Guide to Specifications, Parts I-IV
- Wind Design Guide for Ballasted Single Ply Roofing Systems
- Wind Design Guide for Mechanically Attached Single Ply Roofing Systems
- Wind Design Guide for Fully Adhered Single Ply Roofing Systems

2.2 SBS-Modified Bitumen Built-up¹³

- A. SBS-modified bitumen membranes shall have a minimum cap sheet thickness of 160 mils and shall be reinforced with at least one mat of 100 mil minimum polyester base sheet (260 mils total minimum).
- B. The torchdown method is not allowed with ESM Architectural POC written approval. Comply with LANL Master Specifications 07 5050, Membrane Roofing General Provisions; and 07 5216, Styrene-Butadiene-Styrene Modified Bituminous Membrane Roofing (SBS).

2.3 Metal¹⁴

- A. *Guidance: In general this designation refers to standing seam sheet metal roofs. Many metal roof systems are the product of a pre-engineered metal building manufacturer. If purchasing as part of such a building, comply with LANL Master Specification [13 3419](#), Metal Building Systems.*
- B. The roof shall be designed with a concealed fastener system, except for pre-engineered buildings where capped seam/exposed fasteners are allowable.¹⁵
- C. The designer shall take special care to detail wall-to-roof joints and roof penetrations to ensure a watertight fit and resistance to ice entrapment and ice dam formation. All surfaces perpendicular to roof slope over 12 inches wide require a cricket.
- D. Provide an overhang of 6 inches minimum at the wall.¹⁶
- E. Fabricate fascia, trim, flashing, and other metal components from same material as metal roof panels. Provide exposed metal surfaces with same finish as exposed face of metal roof panels.¹⁷
- F. Panel Materials: Pre-finished and galvanized (or Galvalume-type) steel sheet 24 gage (0.024 inch) minimum.
- G. Architectural Batten or Standing-Seam Metal Roofing: Minimum slope of not less than 2 inches per foot.
- H. Structural Lapped-Seam Metal Roofing (pre-engineered structures only): Factory formed metal roofing panel system with exposed fasteners. Minimum slope of not less than 1 inch per foot. Exposed fasteners to be of matching color with neoprene or manufacturer-approved gaskets.

¹³ Information from ARMA -- Asphalt Roof Manufacturers Association (<http://asphaltroofing.org/>) ARMA Residential Asphalt Roofing Manual and ARMA Guide to Preparing Built-Up Roofing (BUR) Specifications, Recommended Performance Criteria for Roofing Membranes using Polymer Modified Bituminous Products; and Air Force (AF) M91-36, Built-Up Roof Management Program with enclosed BUR Repair/Replacement Guide Specifications.

¹⁴ From MBMA -- Metal Building Manufacturers Association (MBMA) (<http://www.mbma.com/>)

¹⁵ Exposed fasteners tend to leak over time, especially if system is not installed under ideal conditions.

¹⁶ Overhang helps prevent water under-running back to wall.

¹⁷ Dissimilar materials induce corrosion; refer to LANL Site and Architectural Design Principles (http://www.lanl.gov/f6stds/pubf6stds/engrman/4arch/htmls/site_arch.htm) for color palettes.

- I. Comply with LANL Master Specification 07 4113, Metal Roof Panels.

2.4 Shingles and Tiles

- A. **Composition Asphaltic Shingles** - Fiberglass mat reinforced type shingles shall be used if this type of roof is selected and approved for use. Shingles shall be of a minimum weight of 220 lbs per square. Shingles shall not be applied to roofs with slope less than 3 in 12. Comply with LANL Master Specification 07 3113, Asphalt Shingles.
- B. **Clay, Slate, and Concrete Tiles** -- The designer is required to perform a life cycle cost analysis justification prior to selection of this type of roof treatment. Pre-finished metal tile shall only be applied to steep roofs. Other constraints for use of these types of roof systems are defined in the NRCA Publication "Steep Roofing Manual."¹⁸

3.0 ACCESSORIES¹⁹

3.1 Roof Pavers and other Traffic Toppings

- A. Whenever either access frequency or duty level exceeds the guidelines in Tables B30-1 and B30-2, install roof traffic pads or pavers per Table B30-4.

Table B30-4

Roof Usage and Required Protection	
Usage (Traffic) Expected	Required Protection
Equipment Access (Regular)	Recycled rubber traffic pads for walkways and around equipment
Equipment Access (Heavy)	Concrete pavers for walkways & around equipment
Public Usage (General Employee)	Concrete pavers for entire area

- B. Comply with LANL Master Specification 07 7600, Roof Pavers.

3.2 Other Accessories

- A. LANL Master Specifications to be complied with:
 1. 07 6200, Sheet Metal Flashing and Trim
 2. 07 7100, Roof Specialties
 3. 07 7123, Manufactured Gutters and Downspouts
 4. 07 7233, Roof Hatches (where required for access)
 5. 07 9200, Joint Sealants

¹⁸ In addition to adding a large dead load, mineral and ceramic tile roofing treatments have a very high initial cost, so they must be justified by aesthetic desires and long life.

¹⁹ Information from PIMA – Polyisocyanurate Insulation Manufacturers Assoc. -- <http://www.pima.org> and SMACNA’s Architectural Sheet Metal Manual.

- B. Gutters installed on the north side of buildings shall be provided with ice melting/anti-buildup devices.

4.0 FALL PROTECTION

- A. Permanent fall protection anchors, handrails or other fall protection devices shall be provided for all roofs not having minimum 42" high parapets and for which foot traffic near the edge is probable. Perimeters of skylights and roof hatches shall be equally protected. Designs shall also consider the need for fall protection during initial construction per the requirements of 29 CFR 1926. Ref: <http://www.osha.gov/Publications/osh3146.pdf>
- B. Roof access hatches must be given consideration to personnel safety such as use of retractable rails and landings within 7' of the roof hatch underside shall be provided.
- C. Fall protection shall comply with the 29 CFR 1910 (OSHA) requirements.

5.0 REROOFING

- A. *Guidance: This ESM section and the associated LANL Master Specifications govern all roofing at LANL, but of necessity they were written to support new building construction primarily, since re-roofing often presents many unique needs that cannot be addressed in a short standard or master spec. (Figure B30-1 provides only basic guidance).*

As such, when developing a specification package for re-roofing, the LANL Master Specifications may require greater-than-normal levels of editing, augmentation, and supplementation to yield a spec package that adequately addresses all the existing conditions.

Per the LIR, such alterations require the approval of the ESM Architectural POC.

FM&E subject matter experts are available for assistance.

- B. Particular attention must be given to the inventory of existing Systems, Structures, Components, features and equipment on existing roofs or attached to existing structural members including the roof deck whether from above or below. Design shall address these items and a construction (or demolition) sequence shall be provided as part of the contract documents or work order controls. Safety can easily be compromised if this is not done thoroughly.
- C. Code requirements concerning limits of the number of existing roof layers that can have a new roof applied over shall be followed.
- D. Comply with LANL Master Specification 07 0150.19, Preparation for Re-Roofing.